# Center for Integrated Nanotechnologies

# CINT Newsletter

Summer 2008

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## A Message from the Director

We are pleased to share with you our current CINT Newsletter. The Center for Integrated Nanotechnologies (CINT) is dedicated to fostering scientific discovery enabling the integration of nanoscience concepts and structures into the micro and macro world. In this issue we report on the new CINT leadership model, summarize the topics covered in our recent User Workshop, present an update on CINT's User Association, and announce our new user projects along with our upcoming call for user proposals. We also highlight CINT science by describing CINT achievements that have recently garnered external recognition and awards. We are definitely excited about our growing CINT science and user programs!

-Toni Taylor

## User Association Update

The CINT User Association held an election for two new members of the User Executive Committee (UEC). We congratulate Richard Averitt (Boston University) and Karen Kavanaugh (Simon Fraser University) and welcome them to the UEC. They will serve three year terms 2008-2010. Continuing UEC members are: Sanjay Krishna, Chair (University of New Mexico), Julia Weertman (Northwestern University), Atul Parikh (University of California, Davis), Robert Haddon (University of California, Riverside).

Richard Averitt

The UEC represents the larger population of CINT users. It serves as an advocacy group for the Facility and its user community, provides advice to the CINT management on matters affecting the user community and assures open communication between the CINT user community and CINT management. In addition, the UEC will be extensively involved in the planning of the 2009 CINT User Workshop. http://cint.lanl.gov/association.shtml

Karen Kavanaugh

Nominations for UEC members to serve 2009-2011 are welcome and may be sent to Sanjay Krishna, UEC Chair (skrishna@chtm.unm.edu). The election for the new 2009 UEC members will be conducted electronically in the Fall of 2008.

## CINT Call for Proposals is Open

As part of the National Nanoscience Initiative infrastructure, CINT provides user access to technical staff and state of the art equipment for nanoscale science research at no fee to users, except for proprietary research. Individual and team proposals from industry, academia, and other laboratories are welcome. Approved CINT users can access scientific expertise and associated capabilities for research projects aligned with CINT's overall focus on nanoscience integration. CINT's objective is to foster scientific discovery enabling the integration of nanoscience concepts and structures into the micro and macro worlds.

Proposal Content – Specific instructions for applicants and a description of capabilities are available on the CINT web site. In order for CINT to evaluate project feasibility, the User Proposal should clearly state:

- the CINT expertise and capabilities requested
- the specific tasks to be accomplished or work plan
- the estimated duration
- the users that would be conducting the research at CINT.

Collaborations with CINT scientists are encouraged.

Through a separate process, proposals for propriety use of CINT resources (with full-cost recovery as required by the DOE) will be considered. Foreign National users can work at CINT if their visit is planned with sufficient leadtime (see CINT web site). CINT cannot provide financial support to users.

**The proposal submission deadline is September 19, 2008**. Please see the CINT web page for detailed information on the CINT Scientist Summaries and the User Capabilities.

## Successful CINT Workshop Focused on Science

CINT's annual User Workshop was held January 9-10, 2008 in Albuquerque with participation by over 170 attendees representing 31 universities, 11 industries, and 5 government agencies and laboratories. Plenary speakers Evelyn Hu of UC Santa Barbara spoke about the critical role of integration in advancing nanophotonics and Barbara Baird of Cornell University discussed the area of receptor-mediated cell activation which emphasized the highly integrated nature of systems in nanobiotechnology. A new and highly successful aspect of this year's Workshop was the organization of science symposia around active areas of user projects and research at CINT. The Nanowires Symposium was organized by Jennifer Hollingsworth with sessions on: a) *Wet chemical synthesis of inorganic nanowires*, b) *Synthesis of semiconductor nanowires by physical methods*, c) *Properties and characterization of semiconductor nanowires*, and d) *Assembly and integration of inorganic nanowires*, each one of which had overview and new development talks by speakers from the US and Europe along with extensive discussion periods. The Membrane-Based Nanocomposites Symposium was organized by Bruce Bunker and had a similar format, with sessions covering the important areas of: *Nanomaterials in Membrane Assemblies, Adaptive/Programmable Behavior in Membranes, Adaptive/Programmable Behavior in Membranes, and Characterization of Membrane Composites*. A Poster Session with contributions from Users and CINT scientists was also held. The next CINT User Workshop will be organized jointly with the LANSCE Center at LANL and held in early March, 2009.

## CINT Scientists in the News

### National Academy of Engineering Elects CINT Scientist Gary Grest and CINT Advisory Member Frans Spaepen

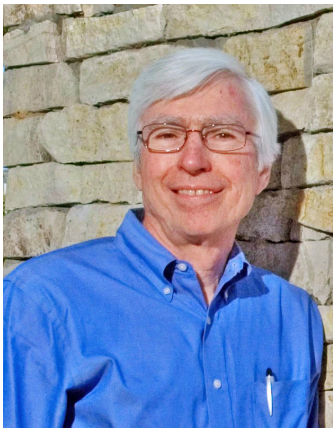
*Gary Grest*

The National Academy of Engineering (NAE) has elected CINT Scientist Gary Grest, and CINT Scientific Advisory Comittee member Frans Spaepen among its 65 new members and nine foreign associates, NAE President Charles M. Vest announced. This brings the total U.S. membership to 2,227 and the number of foreign associates to 194. Election to the National Academy of Engineering is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature," and to the "pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

Gary Stephen Grest, distinguished member of the technical staff at Sandia National Laboratories, was elected for development of large-scale simulations for improved understanding of metals, polymers, and particulate matter.

Frans Spaepen, John C. and Helen F. Franklin Professor of Applied Physics, School of Engineering and Applied Sciences, Harvard University, Cambridge, Mass, was elected for contributions to the understanding of structures of melts, amorphous metals, and semiconductors.

### Tom Picraux named to inaugural class of Materials Research Society Fellows



*Tom Picraux*

Tom Picraux (CINT Chief Scientist) has been elected a Materials Research Society (MRS) Fellow, in recognition for his leadership in the application of ion channeling and ion beam materials modification to materials research, and in the advancement of materials science through research management and professional society service. This is the inaugural year of the title of MRS Fellow, which honors members who are notable for their distinguished research accomplishments and their outstanding contributions to the advancement of materials research, worldwide. The number of Fellows that may be newly appointed in each year is approximately 0.2% of the current MRS membership of over 14,000 members. He was recognized at the Spring MRS meeting in San Francisco, CA.

Picraux joined CINT in 2005 from Arizona State University, where he was professor and executive director of materials research. He is a fellow of the American Physical Society and the American Association for the Advancement of Science. Picraux, who earned his Ph.D. in engineering science and physics from California Institute of Technology, is a recipient of the Department of Energy's E.O. Lawrence Award for his work in materials research

## CINT User Proposals: Spring 2008

CINT has completed the Spring 2008 cycle for user proposals, having approved 162 proposals from among 174 submissions. Once a user agreement is signed, these proposals are active until September 1, 2009. Note that CINT has begun issuing "umbrella" user agreements for approved user projects. These multi-year institutional agreements will expedite processing of the required legal documents for multiple CINT users and multiple CINT projects at the same institution (university, company, laboratory, etc.). Each approved user project will remain valid for one year but can be renewed for a subsequent year by submission of a CINT Renewal Proposal. The umbrella agreement provides a streamlined means to renew projects, launch new user projects, and encourage institutional relationships with CINT.

## CINT Leadership

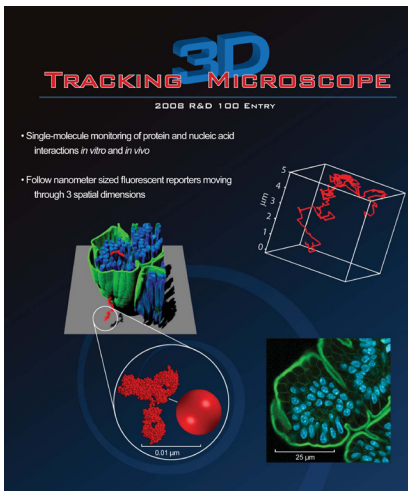
This past spring, the leadership model for CINT was modified by Susan Seestrom, the Associate Director for Experimental Physical Sciences at Los Alamos National Laboratory, and Rick Stulen the Vice President and Chief Technology Officer for Science, Technology & Research Foundations at Sandia National Laboratories after consulting with a number of CINT stakeholders. As a result, Toni Taylor is now the Director of CINT and Bob Hwang is the Co-Director. Toni and Bob will be working closely together to further develop CINT as a single nanoscience center.

## CINT wins R&D 100 award

Jim Werner of the Center for Integrated Nanotechnologies (MPA-CINT), who recently won a coveted R&D 100 award for developing a microscope capable of tracking nanometer-sized objects in three dimensions, is one of the humblest people you'll ever meet.

"I was singled out in the press because I happened to write the application," said Werner, who holds a doctorate in applied physics from Cornell University. "I couldn't have done it without my team." Werner said Peter Goodwin, Guillaume Lessard, and Nathan Wells, all of MPA-CINT, deserve credit for helping to create the revolutionary new instrument.

The team designed the world's first confocal microscope capable of following the motion of individual molecules, quantum dots, organic fluorophores, single green fluorescent proteins, and other nanometer-sized objects as they zoom through three-dimensional space at rates faster than many intracellular transport processes. The microscope will find primary application in cellular biology, where it will help track the transportation of molecules inside cells, Werner said.




The scientist said that his interest in developing the microscope was sparked by a conference on single molecule biophysics he attended several years ago, where there were a number of interesting reports of two-dimensional single molecule tracking. "It became fairly obvious to me that the technology needed to develop into 3-D," he said.

Werner spent the next five years trying to do just that. "Peter Goodwin and I went back and forth with methods," he remembered. "We finally came up with a pretty good design and strategy."

Jim Werner
Photo by Sandra Valdez

The team spent long hours performing simulations, writing software to control the microscope, and building the instrument. Werner said he decompressed by playing soccer, flyfishing, and snowboarding. "I love the outdoors," he said. "That's partly why I love living here in Los Alamos."

Werner said that winning the R&D 100 Award has greatly increased awareness of the technology in the scientific community. The experience also confirmed one of Werner's most closely held axioms.

"I learned a long time ago from Dick Keller (Keller is a Laboratory Fellow and a pioneer of single molecule detection) that scientific discovery is driven by instrument development," he said. "It means so much to all of us that we were able to come up with a successful design."

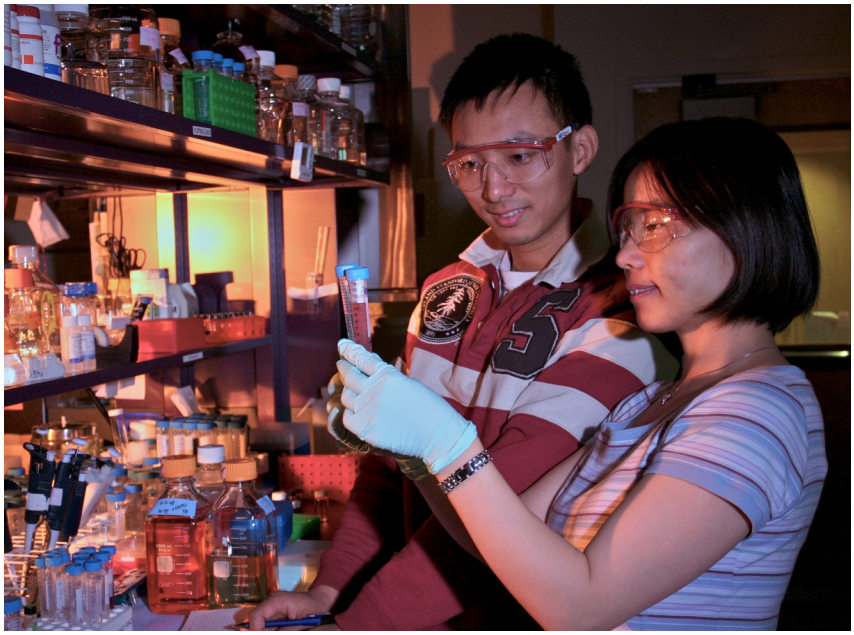
--Tatjana K. Rosev

## Nanomaterials Safety Awards at Los Alamos and Sandia

### Los Alamos -

The nanomaterials hazard assessment team, comprised of Jennifer Martinez of MPA-CINT, Jennifer Hollingsworth of C-PCS, and Betsy Grindstaff of IHS-OS, is being recognized for their rapid and dedicated response to a DOE directive to assess and document the potential hazards associated with research activities using nanomaterials, to put together an institutional directive (P101-29, Working with Nanomaterials and Processes) that serves as the principal guidance for work with nanomaterials, and to contribute to the implementation of this directive through overseeing of revisions to existing Integrated Work Documents (IWDs) involving nanomaterials and undertaking exposure assessments from existing work. This is an ad hoc team that came together in recognition of the potential impact the DOE directive would have on all research activities within the Center for Integrated Nanotechnologies, and more broadly across all research activities at the Lab that synthesize and/or study nanomaterials. The institutional directive document was pulled together in a matter of a few weeks, and implementation of this directive was made possible by the combined efforts of this team.

Nanomaterials research at Los Alamos is a huge and ever-growing enterprise. It is the core business of the Center for Integrated Nanotechnologies, a DOE Office of Science User Facility with a current user base in excess ~ 180 international scientists. In addition, LANL staff engaged in nanomaterials research encompasses at least nine divisions in four directorates. Thus, this is a multimillion dollar piece of our research portfolio, and it represents some of the highest visibility fundamental and mission-relevant work we do. The DOE directive to analyze our risk position and respond with a plan to ameliorate these risks quite literally had the potential to bring ALL nanoscale research to a halt.



### Sandia-

Mike Starr was given a Sandia award for his leadership regarding nanomaterials ES&H activities, not only at CINT but also more broadly at Sandia. Mike is widely recognized as a subject matter expert and is in high demand as Sandia organizations upgrade their laboratory procedures to be consistent with the recommended practices originally developed for the Nanoscale Science Research Centers (NSRCs).

## CINT Wins DOE Secretary's Achievement Award

On March 18th, Secretary of Energy Samuel Bodman presented the DOE Award for Achievement to the SNL/LANL Center for Integrated Nanotechnologies (CINT) at the bi-annual DOE project management workshop in Washington, DC. As one of two DOE engineering/construction projects receiving recognition, the CINT project team was praised for effective management of the construction and instrumentation of two new research facilities, totaling over 130,000 gsf of laboratory, cleanroom and office space. The integrated SNL/LANL project team credited extensive intra-team communication and planning for their ability to respond to unanticipated challenges such as Federal budget continuing resolutions, and construction cost escalations.

Samuel Bodman, Secretary of Energy; William Ortiz, Federal Project Director NNSA Sandia Site Office; Atalf (Tof) Carim, CINT Program Manager, Office of Basic Energy Sciences, Office of Science; Neal Shinn, CINT User Program Manager, Sandia National Laboratories; Ingrid Kolb, Director, DOE Office of Management

# Science Highlight

## CINT and ASU have received a 2008 Nano 50 Award from Nanotech Briefs

The work was lead by former ASU School of Materials student, Sarang Ingole and much of the work was conducted at the Center for Integrated Nanotechnologies (both Los Alamos and Albuquerque sites) as part of a contact development effort for an ASU User Proposal with CINT (U2006A017, Doped SiGe Nanowires for Functional Nanodevices, Steve Goodnick, PI, and Clarence Tracy, co-PI, ASU). This work was also the subject of a journal cover image and letter in Applied Physics Letters in July 2007. Other collaborators in this research were Pavan Aella, Sean Hearne, and Tom Picraux. The Nano 50 will be presented at a special awards dinner to be held during the NASA Tech Briefs National Nano Engineering Conference in Boston, November 12-13, 2008.

### Technologies Category:
### Directed Assembly of Nanowire-Metal Contacts

*Arizona State University,*
*Center for Integrated Nanotechnologies, Los Alamos & Sandia National Laboratories*

To date, nanowires (NWs) of various materials have been fabricated and characterized. They have many novel mechanical, optical or/and electrical properties that make them materials of great interest from fundamental research and practical applications point of view. Any application or investigation on NWs requires them to be connected to their surrounding macro-scale structures. Especially for the purpose of electronic applications, metal-NW contact has to be established, which currently is achieved either through electron beam lithography (EBL) or photolithography. For EBL, NWs are randomly placed on a substrate, e-beam resist is spun and electrode pattern is defined. Prior to resit spinning and pattern definition, NWs have to be located using scanning electron microscope (SEM). EBL while being very precise in writing nano-scale patterns is a serial process, thus not practical for mass fabrication of NW-metal contacts. Standard photolithography also requires placing NWs on substrate followed by spinning of resist and subsequent processes. In both the process, spinning of the resist can disturb the NWs that are loosely placed on the substrate; also coating NWs with resist is undesired because of the difficulty in cleaning their surface afterwards, and the effect of chemicals on the NWs properties. Since the NWs have very high surface area, their characteristics are highly sensitive to any change in their surface. Therefore there is special interest in developing new techniques based on self-assembly that would simplify, and allow mass-scale fabrication of the NW- metal contacts. Being able to avoid photolithography brings added incentive as it saves various resources required for development and addition of any new processes.

We have reported a directed assembly technique in Applied Physics Letters, Volume 91, pp. 033106 (2007) that utilizes dielectrophoresis and standard electrodeposition to align and place the NWs across the planar metal electrodes followed by metal deposition, respectively. This entire process requires only one photolithography step which is for the deposition of metal electrodes on the substrate. After the electrodes deposition NWs are aligned across the opposite electrodes by applying AC electric field. This process results in NW ends sitting on top of the metal electrodes. In the following step electrodeposition is carried out; during this process previously deposited metal electrodes act as selective sites for the electrodeposition of metal. As metal deposits it encapsulates the NW ends. Thus metal deposition on the NW ends is achieved without any photolithography or EBL process. Afterwards, these metal-NW contacts can be annealed to form metal-silicide which is known to result in lower contact resistance.

In spite of significant progress on fabrication and understanding the properties of nanostructures there is big challenge of integrating these structures into useful architecture on a mass scale. Our directed assembly technique shows a way to overcome this challenge. It can be further improved and scaled up for mass production. Besides forming electrical contacts it can also be used in MEMS applications to mechanically hold nanostructures in place.